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(54) Title: PROCESS FOR PRODUCING AN ACTIVE FINE AGGREGATE FOR THE PREPARATION OF CONCRETE

(57) Abstract

The invention relates to a process for producing an active fine aggregate, i.e. an active filler, for the preparation of concrete. In the process are ground pozzolanic substances, practically silica, together with inactive and/or weakly active components, as lump slag, which makes it possible to have the silica in the filler in very small particles activating the surfaces of the other components to react easily with the calcium hydroxide.

Process for producing an active fine aggregate for the preparation of concrete

In addition to cement and cement binders, also various fine aggregates, as for example so-called pozzolanic substances, are used as binders in concrete. These substances are characterized therein that they contain glass-like silicon oxide, which reacts with the calcium hydroxide generated at a hydratation of cement and forms compounds giving strength to the concrete. To the most used pozzolanas belong fly ash produced from the combustion of coal and peat and silica produced from the preparation of silicon. The reactivity of a pozzolana in concrete is influenced except by the chemical composition, also by the grain size thereof. The grain size of silica is considerably smaller than that of fly ash. As the grain size of a pozzolana decreases, the need for water in concrete increases. Therefore, the Finnish concrete standard always presupposes a use of a plasticizer when silica is used.

The bulk density of the silica produced in the industry is very low. To transport and dose it as such into concrete is difficult and even impossible. Attempts have been made to eliminate the problem by pelletizing the silica into very big pellets with respect to its grain size. The problems with transport and dosage are thus eliminated, but the silica does not decompose properly in a concrete mixer, which prevents the silica from acting in the concrete in the best possible manner. Studies have shown that undecomposable silica pellets have been found in a concrete prepared according to the instructions, which pellets do not provide the concrete with the properties searched for by means of the use of sili-

ca. This problem has been decreased by sludging the silica in water before use. Moreover, admixtures have been used at the sludging. The typical content of dry substance in silica sludge is 50 %. Also this process has its drawbacks, as e.g. storing, transport and dosage.

The object of the present invention is to eliminate the drawbacks described above and to provide a process by means of which it is possible to produce in an entirely new manner an active fine aggregate considerably more efficient than the previous ones, the use of which aggregate makes it always possible to achieve the final result desired. This object is achieved by means of the process of the invention characterized in that a raw material mixture is made containing substantially dry inactive and/or weakly active components selected from a group consisting of e.g. limestone, quartz, lump slag, granulated and pelletized blast-furnace slag; and silica or another substance containing an abundance of fine amorphous silicon oxide; and that this substantially dry raw material mixture is ground in a mill or the like, as a result of which joint grinding the silica or the other substance containing an abundance of fine amorphous silicon oxide activates the surfaces of the inactive and/or weakly active components to react easily with the calcium hydroxide.

In the process of the invention, the silica or the other substance containing an abundance of fine amorphous silicon oxide is thus ground in a mill together with the inactive and/or only weakly active materials. The silica, preferably pelletized, then decomposes into very small particles, and according to research, a large part of these particles adheres to the surface of the rest of the material ground and

changes the surface of the inactive and/or weakly active material to react very easily with the calcium hydroxide. Another advantage of the process is that the need for water in concrete does not increase at all even though silica is used. The silica added to the grinding can also be unpelletized. This kind of silica changes during grinding in such a way that it can be used for the preparation of concrete. In practice, the share of the pozzolanic substances is some percentages by weight, as practical upper limit can be considered 50 % by weight.

When using the process of the invention, attention is paid to the grain size distribution of the product created. The grain size distribution is selected in such a way that it fills as well as possible the area remaining between the smallest grains of natural stone aggregate and the largest cement grains, which area by nature lacks grains. Consequently, the average grain size of this product, which can, for instance, be called an active filler, is larger than the average grain size of cement and smaller than that of natural fine aggregate. By using the active filler produced by the process of the invention, it is possible to compensate the lacking grain size area by an inactive and/or weakly active basic material, the surface of which is activated by means of a pozzolanic substance. A product of this kind has substantially cheaper production costs than a product with cement properties having the same effect on the strength development of concrete.

Very fine materials, as e.g. silica, increase the need for water in connection with the preparation of concrete, when they are dosed in traditional manners. The main part of the fine material in the product prepared according to the invention has ad-

hered during grinding to the surface of the basic material, and consequently, it does not increase the need for water in concrete. Because, however, a part of the fine material consists of very small loose particles in the product, a plasticizer, as e.g. lignosulphate, is preferably added into the mill at the preparation of the product, which plasticizer adhered to the surface of the fine particles ensures a dispersion of the fine material in the concrete mix.

Results of research

In tests was used a fine aggregate containing 3 % of silica ground together with lump slag. The dosage of this aggregate into the concrete was 50 kg/m^3. 200 kg/m^3 of cement was used in the concrete. It was possible to prove by means of calculations that the effect of the silica on the compression strength of the concrete at the age of 28 days was 4...5 MPa. To achieve a corresponding additional strength it would have been necessary to add approximately 20 kg/m^3 of cement instead of the 1,5 kg of silica now added. Consequently, the activity of silica obtained was over 10 compared with cement. According to the test results of the literature and to the applicant's own test results, the activity of silica compared with cement is about 3. In accordance with these tests, the activity of silica increased more than threefold.

Example

A typical composition (% by weight) of the raw material mixture and thus of the final product discussed in the process is, depending on the use, as follows:

0 > silica ≤ 10 %

0 ≥ inactive materials, as limestone ≤ 15 %

0 ≥ grinding additive, as lignosulphate ≤ 5 %

the rest weakly active materials, as lump slag.

In connection with grinding, to the mill is preferably added grinding additive contributing to the grinding as well as to a dispersion of the finest grains into the concrete mix.

The grain size curve of the product is adjusted in such a way that it compensates the lacking grain sizes of the concrete in the best possible manner. The grain size distribution is adjusted by dosing into the mill materials to be ground in different ways in a ratio desired. In the product created in this way, the main part of the material belongs to the grain size area of 0...300 µm.

By changing the grading, the activity of the basic material and the quality and dosage of the pozzolana, it is possible to produce different fine aggregates for different concretes.

Claims:

1. A process for producing an active fine aggregate for the preparation of concrete, c h a r a c t e r i z e d in that a raw material mixture is made containing substantially dry inactive and/or weakly active components selected from a group consisting of e.g. limestone, quartz, lump slag, granulated and pelletized blast-furnace slag; and silica or another substance containing an abundance of fine amorphous silicon oxide; and that this substantially dry raw material mixture is ground in a mill or the like, as a result of which joint grinding the silica or the other substance containing an abundance of fine amorphous silicon oxide activates the surfaces of the inactive and/or weakly active components to react easily with the calcium hydroxide.

2. A process according to claim 1, c h a r a c t e r i z e d in that the share of silica or another substance containing an abundance of fine silicon oxide is 50 % by weight at the most, preferably less than 10 % by weight.

3. A process according to claim 1 or 2, c h a r a c t e r i z e d in that the composition of the fine aggregate is as follows:

- 10 % by weight of silica at the most;
- 15 % by weight of inactive components, as limestone, at the most;
- 5 % by weight of a grinding additive, as lignosulphonate, at the most; and
- the rest inactive components, as lump slag.

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 90/00250

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: C 04 B 18/30

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	C 04 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	DE, A1, 2458304 (KROPFHAMMER, GEORG) 16 June 1976, see page 2, line 34 - page 3, line 8; page 5, line 4 - line 8 --	1-2
X	US, A, 4306912 (BENGT FORSS) 22 December 1981, see column 4, line 48 - line 54; column 7, line 43 --	1-2
X	DE, A, 2259898 (STEAG HANDEL GMBH) 12 June 1974, see page 4, line 26 - line 27; page 5, line 5 - line 6 --	1-2
A	BE, A, 839899 (CENTRE DE RECHERCHES METALLURGIQUES) 16 July 1976, see the whole document --	1-3

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* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
24th January 1991	1991 -01- 25
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	May Hallne

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/FI 90/00250

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 90-11-28
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-A1- 2458304	76-06-16	NONE		
US-A- 4306912	81-12-22	AU-B-	537598	84-07-05
		AU-D-	5880480	80-12-04
		BE-A-	883533	80-09-15
		CA-A-	1150327	83-07-19
		CH-A-	644573	84-08-15
		DE-A-C-	3020384	80-12-11
		FR-A-B-	2457845	80-12-26
		GB-A-B-	2051031	81-01-14
		JP-A-	55162456	80-12-17
		NL-A-	8003179	80-12-02
		SE-B-	447097	86-10-27
		SE-A-	8003922	80-12-01
DE-A- 2259898	74-06-12	NONE		
BE-A- 839899	76-07-16	LU-A-	76984	77-07-18